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DISEASE
AND
PUTRESCENT AIR

BY

THOMAS ROWAN

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SOME PRINCIPLES WHICH MUST GOVERN

The Efficient Ventilation of Sewers, and the Effective Hygienic Treatment of "Sewer Gas;"

ALSO,

THE SANITARY VENTILATION OF HOUSE DRAINS AND CONNECTIONS.

BY

THOMAS ROWAN,

Consulting Engineer.

Author of "Spontaneous Combustion & Explosions occurring in Coal Cargoes: their Treatment and Prevention;" "An Examination of the 'Flame' of the Bessemer Convertor;" "The Molecular Action of Impurities in Iron;" "The Estimation of Manganese in Ferro-Manganese;" "An Examination of the Origin of the Loss of H.M.S. 'Doterel;'" &c.

London: E. and F. N. Spon, 16, Charing Cross.
New York: 44, Murray Street.

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A List of Some of the Authorities Consulted.

Reports of the Medical Officer of the Privy Council.

Reports of the Medical Officer of the Local Government Board.

Ballard	Report in respect of the Enquiries as to Effluvium Nuisances.
Liebig	Chemistry in its Application to Agriculture and Physiology.
Pasteur	Studies on Fermentation, &c.
Lionel S. Beale	Disease Germs, Their Supposed Nature.
Sir Thomas Watson	The Abolition of Zymotic Diseases, &c.
Tyndall	Floating Matter in the Air in Relation to Putrefaction and Infection.
Maclagan	Germ Theory of Disease.
A. Carpenter	Preventive Medicine and Public Health.
J. C. Dalton	Physiology and Hygiene.
G. J. Johnson	Epidemic Diarrhœa and Cholera.
Angus Smith	Air and Rain.
Watts	Dictionary of Chemistry.
Fleming	Animal Plagues.
James Johnson	Change of Air, &c.
Parkes	Practical Hygiene.
Baldwin Latham	Sanitary Engineering.
Rawlinson	Suggestions for Main Sewerage, &c. (Public Health Act, 1875).
A. Wynter Blyth	Dictionary of Hygiene and Public Health.
William Eassie	Healthy Houses.
J. Drysdale and J. W. Hayward	Health and Comfort in House Building.
Kingzett	Nature's Hygiene.
Tredgold	Principles of Warming and Ventilating.
Hood	Warming and Ventilating.
Walker	Useful Hints on Ventilation.
Bailey Denton	Handbook of House Sanitation,
Richardson	Various Papers on Hygiene.

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THE Ventilation of Houses, Halls, &c., giving methods for ensuring the constant abstraction of the interior air and control of the *character* of the incoming air, with a minimum of draught.

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HOSPITAL VENTILATION.—Special methods for the Ventilation of the Wards for Contagious Diseases, Surgical Wards, &c., and the *climatic* treatment of air for Consumptives, &c.

DISINFECTANTS.—The Chemistry of Disinfectants and Air Purifiers. Their special application to sanitary ventilation.

TREATMENT OF SMOKE, especially from Domestic sources, as well as the prevention of effluvium nuisances from Manufactories.

PREFACE.

I HAVE considered briefly here only one branch of Sanitary Science, but purpose publishing a Series of Papers on matters connected with Hygiene as time and opportunity allow.

Although as an art Hygiene is of very ancient origin, as a science it is but in its infancy. There are but few branches of natural science which, in their relation to mankind, are so thoroughly practical as Hygiene, or more directly affect every individual. It therefore demands from all a knowledge of its principles, and some acquaintance with its processes. If a man be ignorant of Astronomy, or Chemistry, or Geology, &c., that ignorance concerns more immediately that person himself; but if, by a violation or perversion of sanitary principles or rules, disease be induced, the effects extend far beyond the actual transgressor. It is manifest, therefore, that for the good of all, each person should possess such knowledge of the principles of Hygiene as would ensure their most complete and extended practical application.

The following pages have been written in the hope that they may be found in some small degree to promote the cause of Sanitary Science.

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DISEASE AND PUTRESCENT AIR.

Part I.

SEWERS are necessary to large cities. Although the earth system has been advocated by some, as the panacea for sewer evils, the carrying out of such a system in large cities presents such serious difficulties as to render its adoption impracticable. The most convenient, and indeed, as yet the only practicable plan of transporting sewerage matter through populous cities, is by water carriage through sewers.

The attention of sanitary engineers has long been engaged in this matter, and although much has been done towards perfecting the system of city sewers, much yet remains to be accomplished.

It is true that engineers are so far in accordance as to the best form of sewers—the materials of which they should be constructed—their relative dimensions to the amount of sewerage to be conveyed through them—the best gradients to ensure the proper speed of travel, &c. All this has been very exhaustively investigated; but the proper sanitary treatment of sewer emanations, with the nuisance and danger connected with them, has made as yet but little practical advancement.

It is not my present intention in dealing with this subject to take up the purely engineering aspect of it, as involved in a discussion of size, gradients, &c., or to review the work of others in this respect. I purpose considering it from a more purely hygienic point of view, and to point out what I consider necessary or advisable, in order that sewers may be efficiently ventilated, and sewer emanations effectively treated,—the complete absence of practical methods for dealing with such in cities or towns, having justly caused sewers to be viewed with disfavour and distrust, if not with exaggerated alarm.

The atmosphere of sewers, commonly designated "sewer gas," is a mixture of several gases, some of which are harmless, and others again in their undiluted state are highly poisonous.

The sewerage matter from which these gases emanate is of a complex and varying character, and is derived from the evacuations from the water closets and urinals of houses, &c.—the waste water from kitchen sinks, &c., containing various vegetable and animal refuse,—the drainage from washhouses, stables, cowhouses, slaughter houses, public works, and the like,—and also from various refuse matter from the streets. The gases evolved from these, both as to composition and quantity, depend not only on the nature of this refuse matter itself, but are controlled by several conditions, such as temperature, moisture, the free or limited presence of air, mechanical agitation, light, &c.

The chief elements which take part in the changes developing what is termed "sewer gas" are carbon, hydrogen, nitrogen, and oxygen, and these elements, acted on by the different circumstances affecting their chemical affinities, react on one another, and are transformed or metamorphosed into various compounds, in which the original elements exist in different proportions and altered relations.

Careful examination of sewer gas has shown that it can be composed of a mixture of the following gases, although different conditions alter their relative proportions, and determine the absence or presence of many of them.

SULPHURETTED HYDROGEN.
NITROGEN.
CARBONIC ACID.
CARBONIC OXIDE.
LIGHT CARBURETTED HYDROGEN OR
MARSH GAS.
AMMONIA.
SULPHIDE OF AMMONIUM, AND
OTHER STINKING CARBO-AMMONIACAL
COMPOUNDS.

Such, then, are the gaseous components of "sewer gas."

The effects which are produced by "sewer gas" have been the subject of much controversy, and it has doubtless been accredited with results altogether beyond its sphere of action; some authorities asserting that it can spontaneously generate many forms of disease; others, again, demonstrating that it has no power to create *de novo* specific diseases, while it promotes the development and energy of specific particulate matter imported to it.

Exhaustive researches on this subject have accumulated evidence which renders the former theory untenable, and exhibits that many specific diseases cannot be attributable to chemical action; but as M. Pasteur has put it, are "essentially a phenomenon co-relative with a vital action, beginning and ending with it;" or, as Sir Thomas Watson states: "All these diseases are contagious, but more, they have no other origin than contagion." While the cause of science in this department owes so much to the labours of Hence, Pasteur, Budd, Beale, Lester, Tyndall, and the writings of Carpenter, Watson, Richardson, Maclagan, and others, to none is it more indebted than to those medical officers connected with the carrying out of the Public Health Act of this country, who have for the last 28 years carried on their indefatigable labours and original investigations bearing on this subject, as well as to the valuable and suggestive reports collected and published annually by Mr. John Simon, the late accomplished Medical Officer of the Privy Council, and by his no less able successor, Dr. George Buchanan.

To return, however, to the consideration of the action of "sewer gas." It is evident, at the outset, that there is nothing in its chemical composition that can in any way satisfactorily explain the phenomena of contagion and infection. Sulphuretted hydrogen is its acknowledged most dangerous constituent, the effects of which, when inhaled in a concentrated form, are thoroughly known, and vary with the degree of concentration in which it is inhaled. When largely diluted with air, sulphuretted hydrogen may be breathed for a considerable time without producing any serious symptoms. But where has it ever occurred that a person poisoned, or nearly so, by this gas, has in any way whatever communicated its effects to anyone else, either by contagion or infection? Nay, more, take the whole range of poisons with which we are acquainted, and we find that there is not one single symptom or effect that is communicable, except by the reception of ponderable or particulate quantities in the system of the person exhibiting such.

Again, that contagion, irrespective of "sewer gas," reproduces disease, is beyond controversy. That the contagia of such diseases are specific, and can convey but the same disease and no other to different people is also clear—thus the contagium of small-pox can only communicate small-pox and so on. That a person suffering from any contagious or infectious disease may communicate such disease to another, without the presence of "sewer gas," cannot be denied.

But here we are brought to face the fact that specific diseases of the contagious and infectious order have been traced to the presence of "sewer gas," and removed by its banishment. Did "sewer gas" always communicate one particular form of disease, there might be then reasonable grounds for accrediting it with the origin of such, but the supporters of the "spontaneous generation" theory would endow it with the power of originating the whole range of communicable diseases. It is evident that whatever be the nature of contagium, whether it be of vegetable or animal origin (and I much incline to the latter supposition), it is *imparted* to "sewer gas," and can never be created by it. That disease germs may be frequently absent from it is likely, for it by no means of necessity follows that where there is "sewer gas" there must also be present communicable diseases. Badly drained localities may have for years an immunity from these forms of disease, but when such are epidemic they are most deadly, and the cases most numerous where bad sewer arrangements are present.

The fact that contagious poison may be propagated through the air, has led some authorities to define it as a *volatile* chemical vapour, or æriform body. But dust is conveyed through the air in a similar manner, not on account of its being volatile, but by the extreme lightness of its minute particles. Again, if dust be diluted (if I may use the term) with air, the character of the minute particles of which it is composed is not in the slightest degree altered. The only result will be, that the larger the volume of air with which any given quantity of dust be mixed, the fewer will be the number of dust particles distributed in any measured quantity of such mixture. Indeed if there be one fact beyond others that has been clearly demonstrated by indefatigable research, it is that the physical condition of contagium is particulate, that it is neither volatile in the sense of vapourizing, nor is it soluble or diffusible in the sense of, say, the dilution of sulphuric acid with water. Were contagium a volatile chemical vapour and not particulate, like dust in this sense, we should have a whole range of different kinds or phases of each contagious disease. For example, we would have a dozen or more different varieties or modifications of small-pox, each of which would answer to the degree of dilution, and so with all the other contagious diseases. To use the term "diluted with air," in relation to disease germs, is therefore inappropriate, and conveys an entirely wrong impression. They can be mixed or distributed with air, as can any particulate matter, such as dust. The *smell* of "sewer gas," or any other æriform substance, may be said to be diluted with air.

The suggestive and valuable experiments of Dr. Chauveau, of Lyons, with vaccine and the contagious matter of small-pox and of sheep-pox are referred to in Dr. Burdon Sanderson's paper on the "Intimate Pathology of Contagion," which was published in 1870 in the twelfth report of the Medical Officer of the Privy Council. In regard to these experiments Dr. Sanderson remarks: "They furnish strong additional evidence in support of the doctrine that contagium consists of particles.

They show that whatever may be the degree of dilution, the local effect produced (provided that it is produced at all) is always the same. In other words, the difference between the effect of inoculating extremely diluted liquid, and that of inoculating the liquid itself without any addition of water, does not manifest itself as might be expected in the size of the individual pustule or pustules produced, nor even in the character of the secondary eruption or the constitutional disturbance which accompanies it. The difference lies entirely in the numerical relation of successes to failures. If successful, inoculation with a liquid containing a myriadth of infecting juice communicates the disease as completely as the pure liquid itself.

This fact is not only perfectly consistent with the notion that contagium is particulate, but is in itself a necessary consequence of its being so. If, on the other hand, contagium were soluble, it could not be explained, for in that case each of the 10,000 drops in which the one drop had been dissolved would be equally active. Assuming it to be particulate, it follows that the myriad particles which were before distributed in one drop are scattered through 10,000 drops. And inasmuch as there is nothing excepting the influence of currents to insure the equal distribution of the particles, it is clear that in some regions of the liquid the distance from each other will be greater, in others less. Consequently, when a trace of the liquid thus feebly impregnated with contagium is taken up on the point of the lancet, the chance that the little drop will or will not cóntain particles may be stated numerically by the fraction which expresses the degree of dilution.

And here it is of importance to notice that the same explanation applies to a fact of common observation with respect to all of those diseases which are contagious at a distance. The question is frequently asked, how does it happen that a person may be exposed every day for many months to the contagion of typhus with immunity, and yet be eventually attacked without any change whatever being made, either in his own condition or in that of the infected media by which he is surrounded? If contagium were gaseous the fact would be inexplicable. Assuming it to be insoluble and particulate the question of mediate contagion must, like that of direct contagion, be one of chance. Just as in the case of inoculation the effect of dilution shows itself exclusively in the proportion of failures to the total number of insertions, so in exposure to infected air the effect of distribution of the poison through a large volume of air, shows itself in the proportion of escapes to the total number of exposures which the individual passes through. And just as in the former instance the last inoculation of a series is just as likely to be the one by which a particle of contagium is introduced as the first, so in mediate contagium the last exposure is just as likely to be the effectual one as the first."

While the above is written in that clear and powerful style that is characteristic of Dr. Sanderson's papers, there is one assertion made by him here, which I am not inclined to accept,—viz., that a person may eventually be attacked by the contagion of typhus without any change whatever being made either in his own condition or in that of the infected media by which he is surrounded. I am strongly disposed to believe that the occasion of the attack is very materially regulated by some change in condition which the infected media must undergo; but I shall return to this point further on.

Of the manner in which different contagia or disease germs have originated, much has been written, but little as yet is really known. Many have professed their entire disbelief in their existence, because they have never been *seen*; but were the same test required for every effect or condition surrounding us, how little would remain for us to believe. The *effects* which are produced by different contagia or germs,-their mode of action, their amenability to contain conditions,—disclose to us the fact of their existence. We know that there is such a thing as life by its manifestations; but who has seen the vital principle itself? Is life, then, a myth because it is not cognisable by certain senses? One of old demanded the test of sight to believe a spiritual fact, and was answered: "The wind bloweth where it listeth, and thou hearest the sound thereof, but thou canst not tell whence it cometh or whither it goeth." There is in this answer deep philosophical truth. Although, as yet, we cannot disclose how or where these different germs of disease spring into existence, we at least can know much regarding that from which they can *not* originate.

While for ages it has been observed that epidemics have been traceable to the putrefaction of organic matter, we know that the germs of epidemic diseases cannot derive their origin from such, although these observations establish the fact that the atmosphere of putrescence induces their activity and fosters their presence. Thus, while sewer emanations undoubtedly promote the virulent development of contagia or disease germs, and may also further their propagation; it can never call them into existence or create them *de novo*.

While the natural sequence of facts point to contagium, or seed, or germ, as being specific and particulate, the other factor is still shrouded in uncertainty, viz.,—what is it that induces in the system that condition which renders invasion by such diseases possible? Why, under apparently the same conditions will one person be attacked and another escape? Many have preferred to hold to the doctrine of spontaneous generation, because this cannot be explained to their satisfaction. Because, however, this action is as yet obscure, it surely forms no reason why we should reject what has been made clear; or why theories should be held which are unsustainable save by a tortuous method of reasoning, rather than yield to what is simple, and unstrained, and upheld by actions of a similar nature and results of an analogous or parallel character. The language of science can never own terms so vague as that "there is *something* in sewer gas dangerous to health." The province of scientific research is to define exactly the nature of those actions and reactions which do take place; to exhibit those conditions which may promote or retard them, as well as to indicate those measures by which their morbific effects can be modified or prevented.

It is an observable fact in the history of human progress, that error once received has been harder far to renounce than the reception of truth itself.

Those who profess to hold the doctrine that contagion is but a chemical process, and that the action and generation of the matter of contagion is entirely dependent on chemical forces, and in no way connected with a vital principle, when driven from every vantage ground and met with the facts of demonstrable proof, have taken shelter behind the illustrious name of Liebig. But truth is stronger than the weight of any name, however honoured, or however great. What changes or modifications the views of Liebeg might have undergone in the presence of the accumulated evidence of the present, we cannot tell. But this we do know, that whatever barriers may oppose the march of science—the thraldom of past theories however fascinating, the bondage of error however skilfully covered with the guise of orthodoxy — must be swept aside by the irresistible progress of that which is the aim and highest privilege of science to promote—the cause of Truth.

But to return from this digression. It appears to me that the liability of the system to the invasion of such diseases as we have been considering, may be determined *more* by influences which are outside and apart, than from any special state or condition of constitution or system. I therefore think it likely that the conditions required for the manifestation of such diseases, are not only life in the subject, and its reception of the specific germ, which to produce contagion must likewise be endowed with life (or to use Dr. Beale's term, be *bioplasmic*), and that this contact is requisite to manifest previously latent energy; but more than this, that before this energy can be aroused, the germ itself must have arrived at the proper stage of its own existence and development, and at *some particular phase or condition of that development.* I do not affirm that this is all, or that there must not be also present, some morbid state of constitution or system which furnishes the suitable pabulum necessary for the exhibition of the virulent activity of the germ. Indeed this must be so, from the fact that people having once been subjected to an attack of any of such diseases, seldom suffer from a recurrence of it. In other words, the pabulum or sustenance which the germ seeks is exhausted or absent. In this respect those diseases now classified as zymotic are different from functional or constitutional diseases, one attack of such predisposing to another. The necessity for the presence of this suitable pabulum in the system does not, however, affect what I have advanced.

This may be present as well as the germ itself; unless, however, the germ has arrived at the proper stage of its own development and at some particular phase of this, it is powerless to produce the phenomenon of disease. In other words, the morbid state of constitution or system offers a suitable pabulum *only* to germs which have arrived at one particular condition or phase of their history; and their prior development up to this point is determined by influences altogether outside the person subjected to their malignant attack.

Again, it must be that at this stage and phase of their development, not only are the germs ready to exhibit their virulent activity, but are themselves most vulnerable and easily annihilated by circumstances unfavourable to their progress,—such as the absence of their pabulum or sustenance, and the presence of heat or pure dry air. Were this not so, epidemics could never be controlled by the application of any sanitary measures; and disease germs would become more formidable than the ancient plagues of Egypt, soon depopulating the entire world.

The further progress of scientific research will doubtless, ere long, disclose to us all that is now vague and uncertain; but at the present stage of our knowledge, the practical results to be derived from it direct us to the germs themselves through those conditions which can prevent their propagation and control their energy. The most powerful agents which at present we can employ for this are undoubtedly heat and pure air; the latter being not only the great enemy of disease, but the great ally of health.

Part II.

DISINFECTANTS.—Before proceeding to speak of the practical hygienic treatment of sewers, I purpose dwelling briefly on Disinfectants in relation to their application to sewerage matter.

The word disinfectant in its popular sense, has a vague meaning attached to it, and includes many substances which can simply act as deoderants, antiseptics or absorbents. If disinfectant be understood to be simply a generic term for such substances, I do not quarrel with it, but without a proper division of so-called disinfectants the word is misleading. To use the name, however, in a general sense, disinfectants may be classified as follows:—

1st. DESTROYERS of CONTAGIA or disease germs—or direct or *Primary* disinfectants.

2nd. MODIFIERS or CONTROLLERS of the morbific action of Contagia or disease germs—or *Secondary* disinfectants.

3rd. ARRESTORS or PREVENTORS of putrefaction—or *Antiseptic* disinfectants.

4th. DESTROYERS of putrescent effluvia—air purifiers—or *Deoderant* disinfectants.

5th. ABSORBENTS.—These act by their pores and frequently as well by the oxygen in them. Certain putrescent gases are absorbed and condensed in their pores. When the pores are filled this action ceases, or is scarcely appreciable. The presence of moisture by filling up the pores destroys their capacity for absorbing gases.

The most potent destroyer of all forms of germinal or organic matter is heat. Only a sufficient temperature is required for the total destruction of all the different forms of germinal matter and at every stage of development. Pure dry air is also a powerful destroyer of most germs at certain stages of their development. With reference to this Dr. Tyndall has remarked—"As in the temperature, so in regard to the supply of oxygen, there is a medial zone favourable to the supply of vitality, beyond which, on both sides, life cannot exist."*

It is not my present intention to treat of the nature of chemical disinfectants. This I purpose doing on another occasion. It is certain, however, that chemical disinfectants are practically useless except for abnormal or temporary purposes. I do not seek to affirm that many of the disinfectants with which we are acquainted do not possess potent qualities. The enormous quantities, however, of these disinfectants, which it would be necessary to use to maintain—say the constant disinfection of the sewers and house drains of a city—would soon occasion a worse nuisance and danger than that which they were directed against.

An isolated room or building can be fumigated with chlorine or sulphurous acid, or nitrous acid, or carbolic acid; but who could live in an atmosphere of such?

Doubtless, in cases of established disease, many of these substances are useful and valuable aids, but the great object of sanitary science is the *prevention* of disease by maintaining those conditions which hinder its progress or annihilate its source, and not the treatment of disease itself. In other words, sanitary science directs us how to maintain conditions necessary for the preservation of health and vigour. The treatment of disease is beyond its province.

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* Floating-matter of the air in relation to Putrefaction and Infection.

JOHN TYNDALL, F.R.S., &c.

The sewers of cities are acknowledged to be the great promoters of many, if not all, contagious diseases, and to be antagonistic to health generally. There can be, therefore, no more important problem than accurately to determine how this can be met, and how such conditions can be *maintained* in the sewers of cities which could render them no longer inimical to health. I repeat, that to disinfect a sewer not spasmodically or intermittently but *continuously* (and anything short of this is worthless), by chemical re-agents, whether gaseous or otherwise, is a practical impossibility. The only disinfectant which it is possible to maintain in sufficient volume relative to the matter to be disinfected, or to act in any appreciable degree, is pure air. To put into a London sewer a few tons of chloride of lime or carbolic acid, or any other disinfectant, and expect that such can be effective, is worse than a delusion. We might as well expect, by discharging a few hogsheads of alcohol into the Thames at London Bridge, to be able to detect the spirit in its waters at Woolwich.

Cleanliness and pure air are doubtless the most potent weapons which hygienic science should unceasingly direct. These, indeed, form the *elixir vitæ* of the sanitary art—the transmuter of the "baser metals" of disease and misery to the "gold" of health and vigour.

Part III.

THE VENTILATION OF SEWERS.—We come now to the consideration of the next and practical part of our subject, viz.: The treatment of sewers so as to maintain the maximum conditions for health, and by which epidemic diseases may be controlled within at least minimum limits.

The importance of being able to maintain sewers in a thorough state of ventilation is acknowledged. The successful accomplishment of this has not yet been arrived at. Many plans have been advocated and tried, but up to the present time sewers *remain unventilated.* The greatest results which have been attained are represented in the plan of simply having openings from the sewer to the street, with a grating placed over them. Through these gratings the foul undiluted sewer air makes its way, to the discomfort, if not positive danger, of every passer by. In fact, all that has been arrived at are *minimum* results, viz., preventing a pressure of sewer air accumulating in the sewer; but the sewers are always *charged* with sewerage emanations, instead of having a current of air constantly passing through them. To permit important sanitary conditions to be governed by minimum results is but impotent and illogical. The importance of sanitary science, and the influence it exerts on national health and prosperity, are now becoming too generally recognised to accept anything short of the highest results attainable. I venture to affirm that it is quite possible to ventilate thoroughly any length of sewer, and to maintain in such a constant current of pure air; but this only can be arrived at by methods which are in accordance with physical and mechanical law, to the absence of which the failure hitherto in sewer ventilation is to be attributed.

In 1875 a Royal Commission was appointed to inquire into the spontaneous combustion of coal in ships. In that part of their report which related to "explosions of gas from coal in cargoes," they suggested, as the result of their investigations, that such accidents could be prevented by adopting surface ventilation—that is, ventilation along the upper surface of the coal cargoes. Now, although such recommendations were so far sound, did these accidents cease? On the contrary, as I have elsewhere shown,* during the five years following these suggestions, accidents from explosions increased over 62 *per cent.*, and that on the total quantity of coal carried.

These were the results of so-called ventilation undirected and uncontrolled by scientific and mechanical principles. A few holes were made in the decks, and it was supposed that surface ventilation would ensue.

The same absence of principle is to be observed in the treatment of sewers. "The ventilation of sewers," says one authority,† "although differing from mines, is easy and safe, for only make sufficient openings and the sewers will ventilate themselves." Such a statement as this may, of course, be entirely qualified by the meaning attached to the term "Ventilation." If by ventilation here it is meant that a pressure of gas in the sewer is prevented, then it is easy to understand that having "sufficient openings" will accomplish this; and in this case the ventilation of sewers will more than differ from mines, it will offer no analogy to it. If, however, ventilation is to be taken in the ordinary acceptation of the term, viz., the removal of vitiated atmosphere and its replacement by fresh air, then the ventilation of sewers, by having merely openings, far from being "easy and safe," is perfectly impossible. A sewer is not simply a vessel filled with an obnoxious gas, which, by the law of diffusion, would gradually be replaced by air through simple openings—it does not *merely contain* foul gases, it is constantly *generating* them, and therefore demands that a current of air be directed constantly through it to maintain the conditions necessary for disinfection.

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* Spontaneous Combustion and Explosions occurring in Coal Cargoes, &c. By THOMAS ROWAN.

† Sanitary Engineering, &c. By BALDWIN LATHAM, C.E., &c.

The difficulties hitherto encountered in dealing with the ventilation of sewers, have exhibited that any continuous system of ventilation is not practicable, viz.: Ventilation from one end of the sewer to the other. In his report of the "Brighton Sewerage," 1882, Sir Joseph Bazalgette, referring to experiments made in 1858, for a Committee of the House of Commons, on the effect produced by extracting and burning the gases of sewers by means of furnaces, goes on to remark: "These experiments were conducted with the furnace in the clock tower of the Houses of Parliament, and I subsequently gave evidence before that Committee, to the effect that in the *immediate neighbourhood* of the furnace the indraught was found to be *very strong*, but that, whilst the supply of air was drawn with great force from the sewer *inlets close to the furnace*, the air current produced in the sewers at a *short distance* from the furnace was *scarcely perceptible*."

There is a principle here which must govern all successful ventilation, whether it be of sewers, tunnels, or buildings, and determines the proper relation of inlets and outlets. Beyond the fact that outlets should be taken from the highest point and inlets from the lowest, the position which inlets should relatively occupy to *each other* as well as to the outlets, has not been defined by any recognisable law or principle, but has been left to chance or empiricism.

That principle to which I am now directing attention, but can only briefly dwell on here, may be defined as follows:—An outlet will draw but from the *nearest* inlet, and if this can supply the want created by the outlet, no further action can take place from other inlets, for the volume of air admitted to a sewer, or tunnel, or room, can only be equal to that abstracted from it.

The following experiment will illustrate this:—

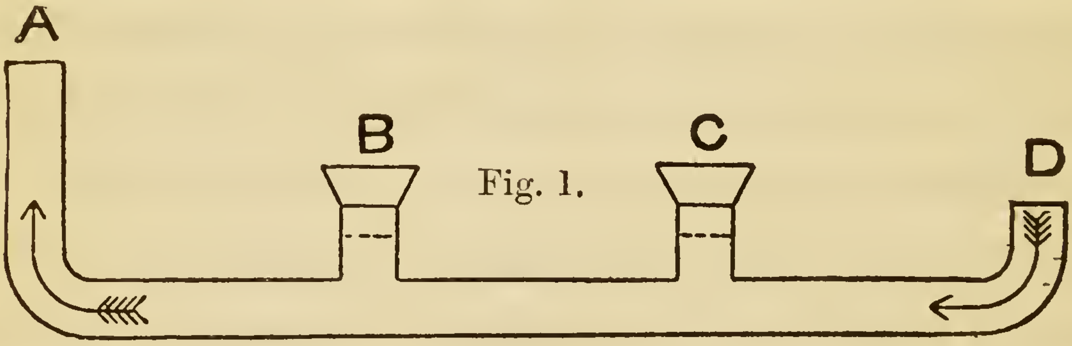


Fig. 1.

Take a tube, as shown at Fig. 1, open at the two extremities A and D, and with tight-fitting corks in the openings B and C. At A create an induced current by means of an aspirator or small vacuum cowl, while holding a piece of smoking touch paper or tow at D. The smoke will immediately travel through the tube towards A, as indicated by the arrows. Uncork now the opening C, while still holding the touch paper at D, and at once it will be seen that but little smoke can be made to travel through the tube; the small amount of smoke that does pass down D makes its way slowly to C, where it again regains its original rapidity towards A.

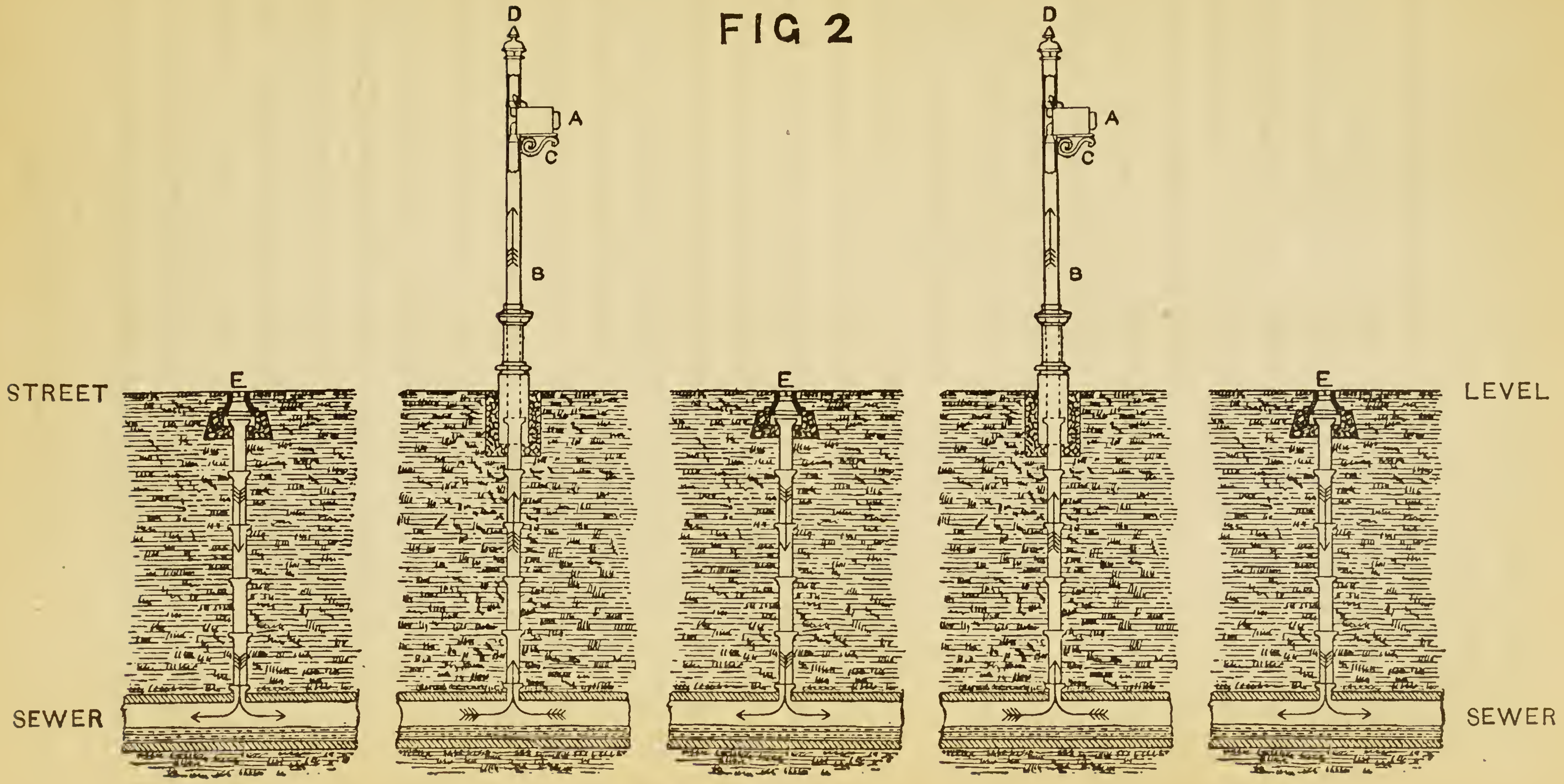
If all the openings are now uncorked, it will be found that not a trace of smoke can be made to pass through the tube from D to A.

The importance of this principle in determining the *position* which all inlets should occupy in relation to each other as well as to outlets, in carrying out the process of ventilation, has been ignored. When it is scientifically applied in buildings, we can ensure that every inlet shall contribute its *equal proportion* of the volume of air admitted, and can thus reduce draught—the bane of ventilation—to a minimum. But I purpose returning to this subject on a future occasion when treating of the ventilation of the interior of buildings, and will then show how various conditions modify in some degree the practical carrying out of this principle.

In relation to sewers, it exhibits why *continuous* ventilation in them is impossible, and has led me to devise an "*intermittent system*" of sewer ventilation, which admits of any length of sewer being so ventilated as to cause a constant abstraction of the sewer air, and its replacement by pure air.

Before proceeding to explain this system, I desire to notice briefly the application of COWLS to sewer ventilation. The growing recognition by the public of the importance of ventilation has led to the introduction or advertisement of a number of so-called "systems" of ventilation which, for the most part, merely consist in the application of a "cowl" or "chimney pot" of more or less peculiar construction. It is quite impossible that any *one* system of treatment or apparatus can embrace the whole range of sanitary ventilation. Different conditions must be met and dealt with in different ways and by different means, if successful results are to be obtained. However suitable some cowls may be to meet the requirements of certain conditions, they are *all alike*

FIG 2



worthless when *continuous* ventilation is required, as in the interior of buildings, sewers, and the like. The efficiency of all cowls depends on the force of the wind; when there is no wind there is no action with any of them, and it is just when there is least wind that ventilation is most required, and least ventilation when there is most wind. The ventilation of sewers must be conducted *continuously*, and therefore *perfectly independently of natural wind force.* By whatever system employed, it is therefore useless and wrong to intrust the abstraction of the atmosphere from the interior of main sewers to cowls of any description, unless mechanical aid is employed.

THE VENTILATION OF SEWERS BY THE "INTERMITTENT SYSTEM."—The object of this system is to subdivide the sewer into sections, so as to ensure its thorough ventilation; each abstractor drawing from the inlets on either side of it, and the inlets consequently delivering air to the sewer in both directions.

Fig. 2 (page 30) illustrates the general features of this system.

The "abstractors" A.A are placed on hollow cast iron pillars B.B as shown. A shaft, one end of which, communicating with the drain, is led up the interior of the pillars, and opens into the lower end of the "gas abstractor." From the top of the "abstractor" the shaft may be continued to any desired height.

The description of the "gas abstractor" will be given further on.

The air enters into the sewers through the inlet gratings, as shown at E.E.E, and divides to the "abstractors" on either side.

The distance which separates the abstractors from an air inlet, does not require to be the same on either side of the air inlet; that is (Fig. 3), if B represents the inlet, and A and C the abstractors placed on either side of it, the distance from A to B, may be greater or less than from C to B.

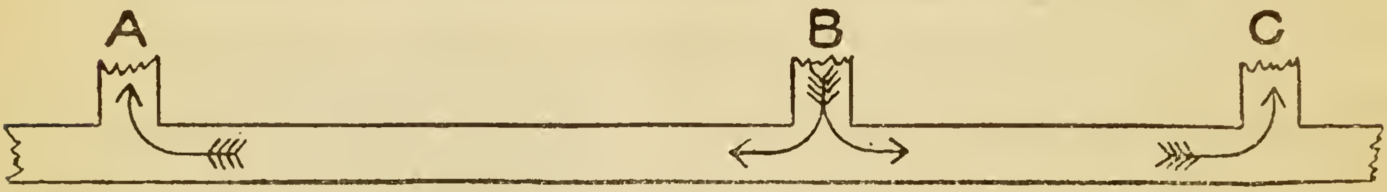


Fig. 3.

But the *inlets* on either side of an abstractor must be at equal distances from the abstractor; that is (Fig. 4), let B now represent the abstractor—and A and C the inlets, then the distance from the inlet A to the abstractor B, must be the same as from the inlet C to B.

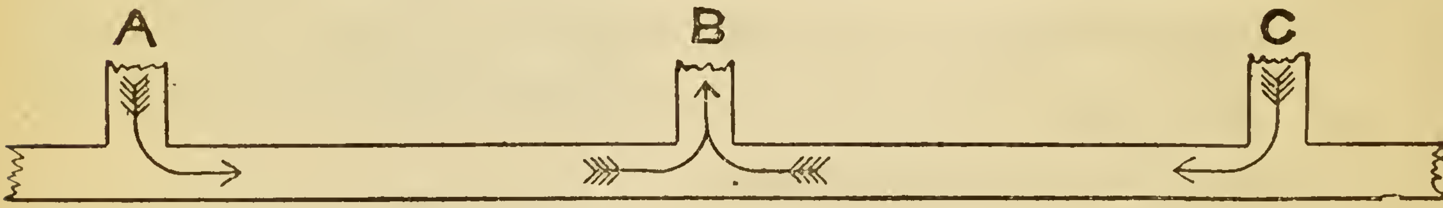
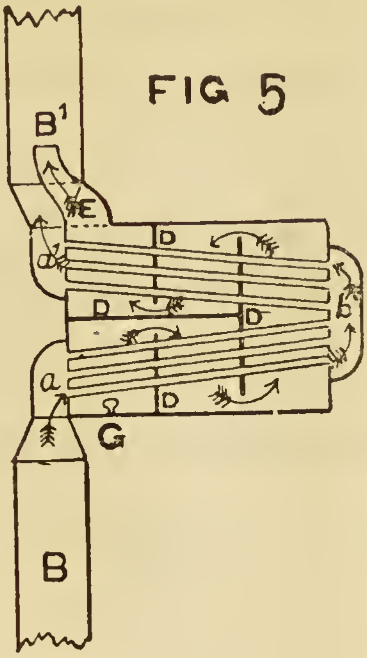


Fig. 4.

These distances may vary with each abstractor. That is to say, an abstractor may have the inlets on either side of it placed at a greater or less distance than those of the adjoining abstractor; but whatever the distance may be from abstractor to inlets, it must be the same, *cœteres paribus*, on either side of each "abstractor."

The "gas abstractor" performs a double function; not only does it constantly abstract the sewer air from its section of the sewer, and therefore induce the continuous replacement of this with fresh air, but it also burns and destroys any organic matter in the atmosphere ejected from the sewer.

Fig. 5 shows in section one form of the gas abstractor.



B is the pipe or shaft leading from the sewer to the bottom of the abstractor, in which the sewer air is made to travel through a series of small tubes *a* into the chamber *b*, and again through another series of similar tubes *a'* to the shaft B^1. These small tubes are heated externally by means of the atmospheric gas burner shown at G, and the heated products of combustion are made to pass over and amongst those tubes by means of the deflecting plates DDD, and finally to make their way through the funnel E, where they meet and mingle with the sewer air at B^1. It will thus be seen that those abstractors are, in fact, small furnaces in which a large amount of heating surface is obtained, and by which a very considerable induced current is created.

By this system of treatment any length of sewer is subdivided into sections for purposes of ventilation, *without in any way interfering with the flow of the sewerage matter.* It is imperative that the "flow" in sewers be not impeded; any plan, therefore, that can offer obstruction to the travel of sewerage matter in sewers, is thoroughly wrong in principle.

The volume of fresh air which by the "*intermittent system*" of ventilation could be made to pass through a sewer, would be relatively so great to the amount of sewer gas generated, as to render the latter imperceptible as far as smell was concerned. It will be also observed that by this system it is possible to employ the *two primary* disinfectants and only germ destroyers,—viz., heat and pure air—in the treatment of sewer emanations.

This system is susceptible of further elaboration.

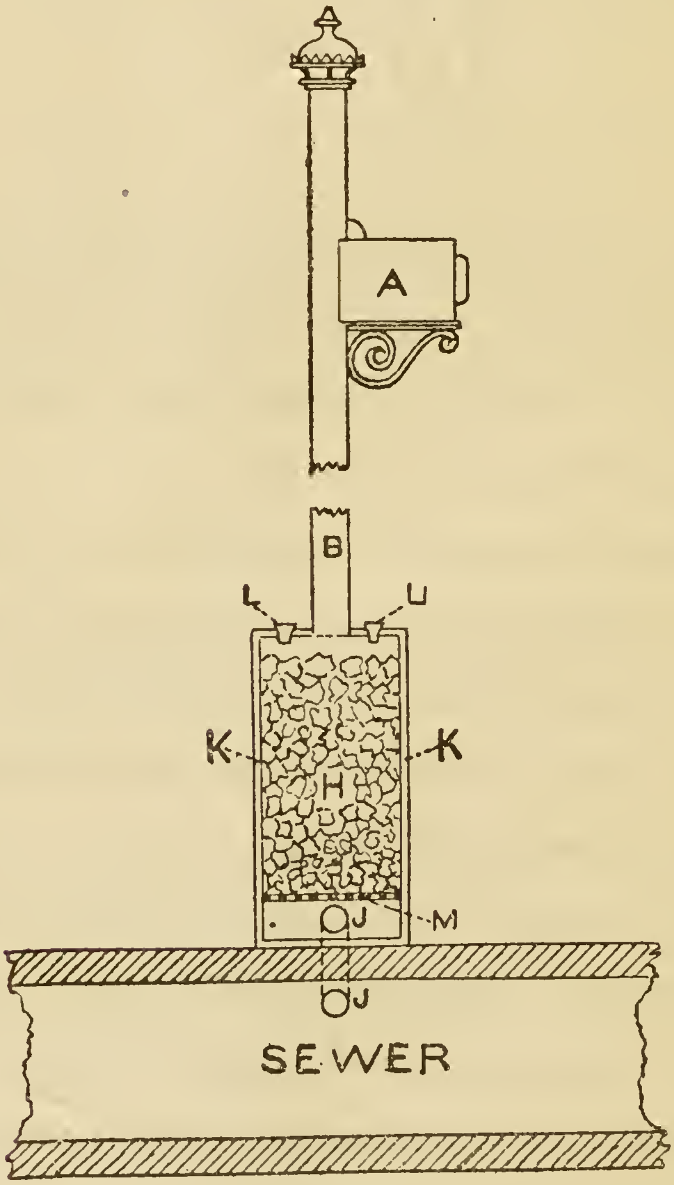


Fig. 6.

DESCRIPTION OF FIG. 6.

K.K is the chamber having a perforated false bottom M on which the Foundry Coke H rests. J.J are the pipes opening from the sewer to the chamber K.K below the false bottom M. The disinfectants, &c., are introduced through the charging holes L.L to the chamber. The shaft B from the top of the chamber passes up to the "gas abstractor" A, as described in fig. 5.

Instead of abstracting the sewer air directly from the sewer by means of the gas abstractor, it may be first made to pass through a chamber (Fig. 6) in which is placed foundry coke saturated with any desired disinfectant or air purifier. These disinfectants could be renewed from time to time, as required, through suitable openings at the top of the chamber. I have chosen foundry coke on account of its very porous and open structure, and have found it admirably suited for the treatment of air.

Another plan is to use this chamber simply to filter the sewer air on its passage to the gas abstractors, as at fig. 6. The foundry coke in this case is simply treated with coarse glycerine, chloride of magnesium, or similar substance. In the passage of the sewer air through the coke, germinal matter would in great measure be detained by adhesion to the surface of the coke so treated. The coke would be removed periodically, and either burned, or disinfected by submitting it to a sufficiently high temperature, when it could be again replaced in these chambers.

Although I think the plan as shown at Fig. 2 sufficient for all general purposes, yet in times of epidemics, such as cholera, &c., this further treatment would be of value.

It may not be out of place to mention here that I have devised a modification of this plan for the abstraction and treatment of air from the "Contagious Wards" of Hospitals. The interior air of these wards, containing as it does the *germs* of *such diseases*, would therefore be disinfected prior to its escape to the atmosphere without; and this is as important and imperative as in the case of sewers. Were pure air not as powerful a destroyer of disease germs as assuredly it is, the vicinity of such hospitals would be most dangerous to health. As it is, in damp weather, when the air is surcharged with moisture, the germs of many contagious diseases, doubtless survive their contact with the outer air, and may be wafted to soil or circumstances where again they can renew their condition of morbific activity.

And further, just as the abstracted air can be treated from the wards of hospitals, so can the air be dealt with which is admitted to such wards, and its character can be so controlled that those different conditions of atmosphere can be maintained which correspond to different climates. This, however, can only be done thoroughly and scientifically to be of practical use. To scatter about the wards a few vessels filled with disinfectants or medicants, or to hang up cloths which are saturated with these, is a very unscientific and unsatisfactory method of treating air. *Every portion* of the air that enters the ward should be, and can be, under perfect control, as can also the air abstracted from it. I am convinced that scientific ventilation and the climatic treatment of air, have an important future in their application to hospitals and sanitoriums.

NOTE.—These gas abstractors and air-purifying chambers can be practically applied to the ventilation of the UNDERGROUND RAILWAY through London; but I purpose referring to this on some other occasion. I will merely here mention that the nuisance anticipated—and I think very reasonably so—from the ventilating shafts of the District Railway, which are at present in course of erection in Westminster, and along the Embankment, might be completely avoided. Merely sticking down so-called ventilating shafts, however, will not ventilate these tunnels any more than they can sewers, to which at present, in many respects, they are analogous.

That Ventilation is imperatively required in the Underground Railway is acknowledged. And while the Railway Companies should doubtless possess the power of making any arrangement requisite for the maintenance of a purer atmosphere in their underground way, they should first be able to demonstrate, before encroaching on the property of others, that the methods they purpose employing will be effective. They should not have the power of erecting shafts that may be unsightly, and as useless as unsightly. In other words, if the Railway Companies are to be able to put down shafts *where* they please, they should not have the power of doing this *as* they please. Their ventilating arrangements should be shown to be efficient, and they should be compelled to have the abstracted atmosphere from their tunnels so treated in its passage to the outer air, that it would not be a source of nuisance to the people in the locality.

There is no doubt that travelling in the Underground Railways could be rendered much less objectionable and less injurious to health, were the carriages properly ventilated—that is to say, were the interior air constantly abstracted from the carriages, and the air admitted to them filtered and purified. This is not only possible, but by no means difficult to accomplish; and there is no reason why the character of the incoming air should not be controlled at pleasure, from simple filtration from dust and soot particles to absolute purity—that is, both mechanical and chemical impurities can be removed. The whole matter resolves itself into one of cost; but it is quite possible, at a small cost, to greatly improve the quality of the atmosphere which the passengers have to inhale in the carriages of Underground Railways.

I have devised a simple "automatic abstractor" which derives its action from the onward motion of the carriage, while the air admitted to the interior of the carriage is forced by the same onward motion through a small "filtering chamber," which it is unnecessary to describe here. The air, in its passage through this "filtering chamber," is freed from dust, &c., and the carbonic acid and sulphur vapours, removed by suitable absorbents, such as by any of the caustic alkalies. Sulphuretted hydrogen can also be entirely removed by proper treatment with hydrated ferric oxide, or by a solution of plumbic oxide in caustic soda, as suggested by Dr. A. Smith, for removing sulphuretted hydrogen from coal gas—or the air can simply be filtered and treated with any inodorous disinfectant.

One word more. If ventilating the Underground Railways is found to be so difficult, it would be interesting to know how the promoters of the Channel Tunnel Railway propose to effect the ventilation of their tunnel.

Part IV.

THE SANITARY VENTILATION OF HOUSE DRAINS AND CONNECTIONS.—The treatment of house drains and connections is distinct from that of sewers. The conditions to be dealt with are quite apart from those met with in sewer ventilation.

It is comparatively an easy matter to construct new houses with perfect sanitary arrangements. The great difficulty which the sanitary engineer has often to encounter, is the adaption of any satisfactory system to the defective arrangements of the drains and connections already existing in most houses of the present day. These often demand different methods of treatment; and care and judgment must be exercised when applying any sanitary system, that matters of detail are efficiently attended to.

The importance of having house drains in a perfect sanitary condition cannot be too highly estimated. There are few things, however, more grossly neglected, or more imperfectly carried out. Constantly, even in modern houses, we find the following state of matters:—

The water closets built in the centre of the house, surrounded by bedrooms, &c., instead of being placed at the outside walls, or better still, jutting out altogether from the building. Soil pipes directed with all kinds of inclinations for inducing the lodgment of soil matter, instead of having a straight perpendicular fall to the drain. The waste water from bath rooms or sinks, led into the soil pipe, instead of being directed into a separate pipe having a good fall on to an uncovered grating, and furnished with an open heading into which the waste water flows.

Another dangerous arrangement in houses, but happily now becoming less frequent, is having a cistern supplying water both for drinking purposes and for flushing the water closets. Nothing can be more dangerous than this, or more opposed to every sanitary precept. What is more commonly met with, but not one whit less dangerous, is the overflow pipes from cisterns being led into the soil pipe or drain, instead of in every case being delivered into the open air, where nothing but pure air can make its way back through them to the cistern.

Again we find that TRAPS are trusted to, as the barriers which are to exclude the entrance of sewer gas to the house. This is most delusive, as however good adjuncts traps may be when in suitable positions, they are all quite unreliable. Not only will any slight increase of pressure (such as might be occasioned by any elevation of temperature in the drain) send the sewer air *through* the water of the trap, but, as the sewer gas is absorbed by the water at the sewer end of the trap, it is slowly evolved from the water at the house end. Traps are also liable to siphon, or become untrapped. This happens if the flow of water in the drain pipes fills the bore, or as it is termed, when "running full." In doing this the water as it travels forces the air in the pipes before it, and the rush of air behind, which seeks to fill up the space left by the running water, will often completely unseal the trap.

Such, then, are some of the difficulties and conditions to be dealt with, in the successful treatment of that branch of sanitation which embraces the ventilation of house drains and connections.

In dealing with sanitary measures in their application to the drains of dwelling-houses, and in order to arrive at any intelligent apprehension of the matter, it is necessary to understand :—

1st.—What are the conditions to be avoided.

2nd.—What are the conditions to be maintained.

When these are thoroughly understood, it will be seen that in the scientific application of methods to effect the exclusion demanded by the former, we can offer conditions in which we are enabled most satisfactorily to maintain the requirements of the latter.

I do not think it is necessary now to do more than merely summarize, as below, those various conditions and requirements which should always be observed. It may serve in some measure as a sanitary chart to the householder, to help him in ascertaining for himself whether the sanitary state of his dwelling is as it ought to be.

1st.—That the main sewer be practically shut off from the house connections, so that sewer gas from the main sewer be not allowed to find a passage through any portion of the house drains.

2nd.—That a current of fresh air be constantly maintained throughout the whole system of house drains and connections in every house. Nothing *less* than this is satisfactory, or should be allowed.

3rd.—That nothing be permitted to enter the soil pipes but soil matter from the water closets.

4th.—That all soil pipes have a straight perpendicular fall to the drain.

5th.—That provision be made for the action resulting from flushing the soil pipes by the water closet, when the air in the soil pipes is pushed before, or displaced by the falling water and soil matter.

6th.—That the water closets in a house be built jutting out from the house, or at least be at the outside walls.

7th.—That all waste water from bath rooms, sinks, &c., be led into a separate pipe having a good fall on an open gully trap, and furnished with an open heading, &c., to which the waste water be directed.

8th.—That cisterns used for flushing water closets be entirely separate and exclusively apart from the supply of drinking water, or that used for domestic purposes.

9th.—That all overflow pipes from cisterns be delivered into the open air, and must never under any circumstances be led into soil pipes or drains.

10th.—That provision be made so that traps should not be unsiphoned by flushing the drains.

11th.—That the drains should be laid in such gradients as will ensure a proper speed of travel of all soil matter to the main sewer.

12th.—That all drain pipes be *thoroughly jointed.*

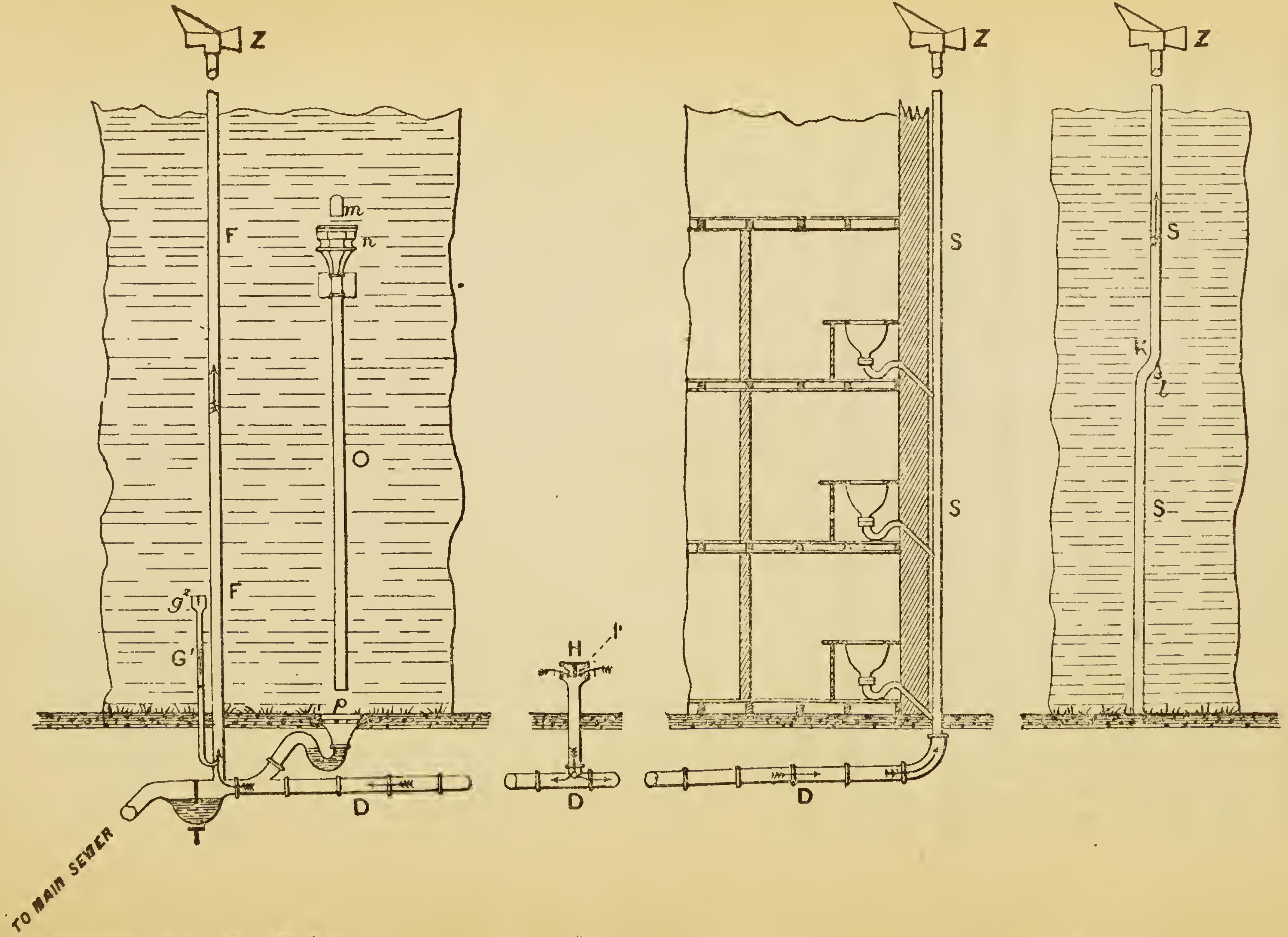
13th.—That provision be made for occasionally flushing the house drains, especially in hot weather.

14th.—That no drain be allowed to pass through a house on any pretext whatever.

15th.—That, consequently, no gully trap be allowed inside of a house.

To the above I may add, that all *dust bins* where, in addition to the ashes, the refuse matter from the kitchen is thrown, should be as thoroughly ventilated as the drains themselves. The putrefaction of organic matter when started, progresses in a rapidly increasing ratio; in hot weather, when this action is greatly intensified, all dust bins, which are as well the receptacles for any organic refuse matter from kitchens, should be cleaned out *at least twice every week.*

I now desire to direct attention to the following system of sanitary ventilation, named the "Manchester System," which is most simple in character, and has been found to effectually carry out the sanitary requirements of house drains and connections, as stated above.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DDD.—The House Drain running outside of the house.

T.—Trap communicating with the main sewer.

FF.—Main Shaft which rises from the house drain on the house side of trap. Any sewer gas which finds its way from the sewer through the trap (**T**) will at once be carried up this shaft, and so be prevented from passing into the house drains past this point.

G^1.—Air Injecting Pipe.

ZZZ.—COWLS. When a *continuous* abstraction is required independently of wind force, and therefore of the action of Cowls, this shaft is fitted with a Patent Gas Abstractor. In ordinary houses, however, a Cowl of the description here shewn, is found to be sufficient for the drains. If the house be surrounded by higher buildings which cause deflections of the air currents, other forms of cowls would be more suitable.

O.—A pipe or shaft with an open head **n**, having a fall to an open grating **p**, communicating, as shewn, with the drain. The waste water from bath rooms or sinks is delivered into the open head, as at **m**.

SS.—Soil Pipe connected with the water closets, and carried above the level of the roof, as shewn. Above the top W.C. the soil pipe is elbowed, as at **K**, and provided with air injecting cones **l**. The soil pipe is also furnished with a cowl, as shewn.

H.—Air inlet box or shaft communicating with the drain ; the valves **i i** of the air inlet box. These valves open *inwards*, and can be regulated to any desired pressure. **i^1** is the Dividing Plate in the air inlet box. The air injecting pipe **G^1** is also provided with one of these, as shewn at **g^2**. Air will pass into the drain **D D**, through the valves **i i** in the inlet box **H**, so that there will be practically a constant current of external air towards the main shaft **F F**, which cuts off the main sewer from the building, and it likewise ensures a current of air passing freely up the soil pipe **S S**; the course of the air current being indicated by arrows. The valves of the inlet box, in the top of the air injecting pipe, prevent any escape from the drain should there be no wind to cause action with the cowls. When the soil pipe is filled with water from the flushing of any of the water closets, the air pushed before the flow of water is drawn up the main shaft ; and to prevent the trap **T** from siphoning when the flush flows beyond it, an air inlet box with valves opening inwards, can be fitted on the delivery end, although this is not shown in the sketch.

If the drains of a house are arranged in a manner similar to that shown at Fig. 7, so that the sewer be shut off from them, and a current of air caused to pass freely through the drains, the abstraction of the air from them may be intrusted to suitable cowls. With such an arrangement the absence of wind and consequent inaction of cowls would seldom be long enough to allow an accumulation of sewer gas to any extent in the drains. In hospitals, however, where the water closets are in frequent use throughout the whole day, the abstraction should be effected by artificial means, such as the employment of a gas abstractor, as shown at page 33 (Fig. 5).

In conclusion, I would again refer briefly to TRAPS. As a general principle, any trap through which soil matter has to be conveyed should be so constructed that its delivery leg be at a less angle and be shorter than its receiving leg; that is to say, the end which delivers to the sewer should be shorter and at a less angle than the end which receives from the house side. By these means a sweep through the trap of the soil matter will be ensured, and any lodgment of it in the bend be prevented.

Traps are most useful adjuncts when placed in proper positions. A great amount of the outcry against traps is due to the ignorance displayed in giving them work to perform for which they are unsuited, and this has resulted in the extreme cry of no traps at all.

A trap should not be employed that has moveable parts. The simpler they are the better. And if a trap be placed in a position where, to act effectively, it requires moveable parts, depend upon it, that is the very spot unsuited for a trap at all. The oxidizing effect of moisture and damp air, and the corrosive action of sewer atmosphere, must soon destroy the action of any mechanical trap. Therefore traps having mechanical movements should never be employed in house drains.

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VENTILATION.

A FEW PRINCIPLES WHICH SHOULD
GOVERN SANITARY VENTILATION, AND EXPLANATION OF
THE "MANCHESTER SYSTEM"
(Rowan's Patents).

MANCHESTER:
THE "MANCHESTER SYSTEM" SANITARY ENGINEERING CO.,
39, SOUTH CORRIDOR, ROYAL EXCHANGE.
LONDON:
5 & 6, PALACE CHAMBERS, BRIDGE ST., WESTMINSTER, S.W.
1883.

PRICE ONE SHILLING.

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VENTILATION.

THE importance of sanitary science and practical Hygiéne has never been so fully recognised as at the present time. Although Hygiéne, as an art, is of ancient origin—even before the time of Hippocrates—yet as a science it is of modern date.

Hygiéne is capable of numerous sub-divisions, but at the outset it may be broadly divided into two parts, viz. :—

SCIENTIFIC HYGIÉNE. PRACTICAL HYGIÉNE.

Scientific Hygiéne treats of those laws and conditions mental and physical, the violation of which leads to suffering and disease—and the observance of which are requisite to the maintenance of health and vigour of mind and body.

Practical Hygiéne treats of the methods and processes by which these hygiénic laws and conditions can be continuously sustained, amid the circumstances and surroundings of life.

In the practical application of sanitary science, there is no process that occupies so prominent and essential a position as that of *Ventilation*, and there are few things more difficult to accomplish satisfactorily. The conditions and requirements are so varied and diverse, which the art of ventilation is called upon to meet, that even at this present time the want of thorough and efficient methods, and treatment applicable to such, is very widely felt and acknowledged.

This want has led to the introduction or advertisement of a number of so called " systems " of ventilation which, for the most part, merely consist in the application of a "cowl" of more or less peculiar construction. However suitable some cowls may be to meet the requirements of certain conditions, they are all alike worthless for purposes of general ventilation of the interior of buildings, rooms, &c.; for in such the *continuous* abstraction of the atmosphere must be assured, as well as its replacement with pure air. The efficiency of all cowls depends on the force of the wind; when there is no wind there is no action with them—and it is just when there is no wind that ventilation in the interior of buildings, &c., is most required. These remarks are thoroughly applicable to the ventilation of main sewers. By whatever system employed, it is useless and wrong to intrust the abstraction of the air from the interior of main sewers to Cowls of any description, unless mechanical aid is employed.

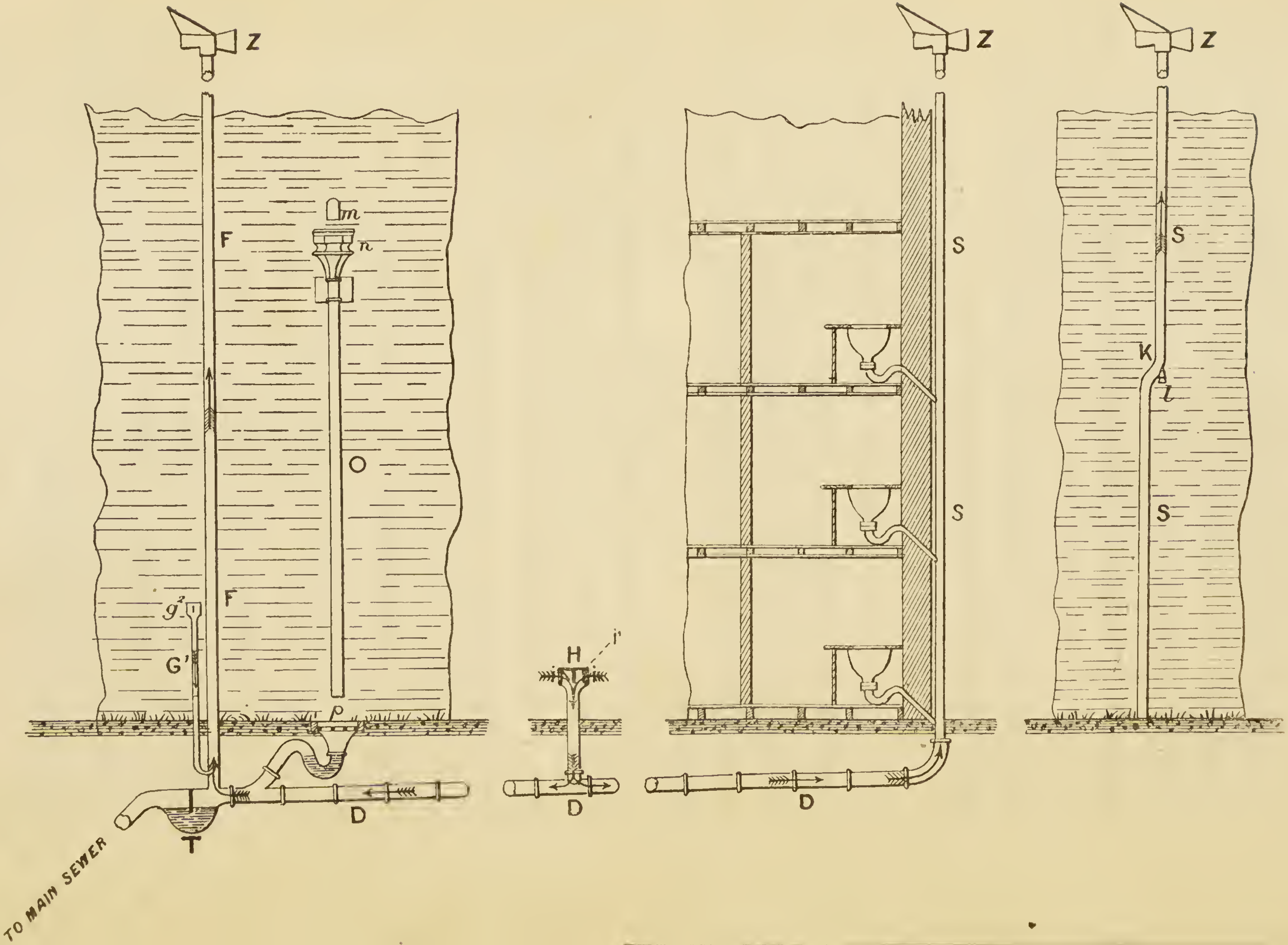
It is quite impossible that any one system of treatment or apparatus can embrace the whole range of sanitary ventilation. Different conditions must be met and dealt with in different ways and by different means, if successful results are to be obtained. For instance, the ventilation of sewers demands very different treatment from that of house drains, and both again are widely apart from the conditions we have to meet in the ventilation of the interior of buildings, &c., &c.

The "Manchester System" Sanitary Engineering Co. have much pleasure in stating that the different requirements exhibited in the ventilation and treatment of sewers, house drains, interior of buildings, ships, &c., &c., and the simplest and most effective methods of meeting such, have been successfully worked out by Mr. Rowan; and that they are now prepared to undertake the carrying out of all sanitary works under the sanitary patents of Mr. Rowan, which they have secured.

It is impossible, within the limits of this pamphlet to do much more than briefly describe the objects and scope of Mr. Rowan's methods, to which it is proposed to give the name of the "*Manchester System.*" A sketch, however, is here given, with explanatory notes, of the system as applied to house drains and connections.

By reference to the sketch it will be observed that the sewer-air from the main sewers is not allowed to enter the house drains, and at the same time any lodgment of foul air in the soil pipes, &c., is prevented. In public institutions, &c., or in private houses, the ventilation can be carried on *continuously*, and therefore, independently of any force derived from the wind When this is desired the main shaft is provided with a "gas extractor" instead of a cowl, as shewn in the sketch.

In ventilating house drains, it is not enough to aim at merely preventing any *pressure* of sewer gas in them—that is but a minimum result. *Nothing less* is satisfactory than maintaining a current of fresh air throughout the whole system of drains in any dwelling-house.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D.D.D.—The House Drain running outside of the house.

T.—Trap communicating with main sewer.

F.F.—Main Shaft which passes from the house drain on the house side of trap.

G'.—Air Injecting Pipe.

Z.Z.Z.—COWLS. When a *continuous* abstraction is required independently of wind force, and therefore, of the action of Cowls, this shaft is fitted with a Patent Gas Abstractor. In ordinary houses, however, a Cowl of the description here shewn, is found to be sufficient for the drains.

O.—A pipe or shaft with an open head **n**, having a fall to an open grating **p**, communicating, as shewn, with the drain. The waste water from bath rooms or sinks is delivered into the open head, as at **m**.

S.S.—Soil Pipe connected with the water closets, and carried above the level of the roof, as shewn. Above the top W.C. the soil pipe is elbowed, as at **k**, and provided with air injecting cones **l**. The soil pipe is also furnished with a cowl, as shewn.

H.—Air inlet box or shaft communicating with the drain ; the valves **i i** of the air inlet box. These valves open inwards, and can be regulated to any desired pressure. **i'** Dividing Plate. The air injecting pipe **G'** is also provided with one of these, as shewn at g^2. Air will pass into the drain **D D**, through the valves **i i** in the inlet box **H**, so that there will be practically a constant current of external air towards the main shaft **F F**, which cuts off the main sewer from the building, and likewise ensures a current of air passing freely up the soil pipe **S S**; the course of the air current being indicated by arrows. The valves of the inlet box, in the top of the air injecting pipe, prevent any escape from the drain should there be no wind to cause action with the cowls. When the soil pipe is filled with water from the flushing of any of the water closets, the air pushed before the flow of water is drawn up the main shaft, and to prevent the trap **T** from siphoning when the flush flows beyond it, an air inlet box with valves opening inwards, can be fitted on the delivery end, although this is not shown in the sketch.

SEWER GAS has doubtless been accredited with results beyond its sphere of action. But whether the contagia of epidemic and communicable diseases be formed *de novo* in a putrescent atmosphere, or that such an atmosphere presents but the congenial soil which pushes specific germs into energetic reproduction and virulent activity—medical men are at least agreed in regarding sewer gas as not only inimical to health, but as the great ally of disease.

The process of inhaling air, and the inverse action of exhalation, commences with life, and only terminates with death. The duration of life, and the degree of health and vigour maintained during its span, is determined in great measure by the character of the air we breathe. There is nothing therefore of more vital importance than pure air, but there are few things less understood or more neglected.

Although man must die, if from no other cause than old age, to all human observation there is no reason why any other cause *must* occasion death. Disease is not the necessary effect of natural existence, but the result of the inversion and violation of natural laws. Among the most prominent of these is the breathing of impure or vitiated air.

It is astonishing that while we build our houses with due regard to comfort—with windows to admit light—fire-places to give out warmth, &c., so little regard is paid to the maintenance of a pure atmosphere in the interiors. Constantly, even in modern houses, we find the following state of matters—

The water closets built in the centre of the house surrounded by bedrooms, &c., instead of being placed at the outside walls, or better still, jutting out altogether from the building. Soil pipes directed with all kinds of inclinations for inducing the lodgment of soil matter, instead of having a straight perpendicular fall to the drain. The waste water from bath rooms or sinks, led into the soil pipe, instead of being directed into a separate pipe having a good fall on to an uncovered grating, and furnished with an open heading into which the waste water flows, as shewn in our sketch.

Another dangerous arrangement in houses, but happily now becoming less frequent, is having a cistern supplying water both for drinking purposes and for flushing the water closets. Nothing can be more dangerous than this, or more opposed to every sanitary precept.

Again we find that **TRAPS** are trusted to, as the barriers which are to exclude the entrance of sewer gas to the house. This is most delusive, as however good an adjunct a trap may be when in suitable positions, they are all quite unreliable. Not only will any slight increase of pressure (such as might be occasioned by any elevation of temperature in the drain) send the sewer air *through* the water of the trap, but, as the sewer gas is absorbed by the water at the sewer end of the trap, it is slowly evolved from the water at the house end. Traps are also liable to siphon, or become untrapped. This happens if the flow of water in the drain pipes fills the bore, or as it is termed, when "running full." In doing this the water forces the air in the pipes before it, and the rush of air behind, which seeks to fill up the space left by the running water, will often completely unseal the trap.

Such, then, are some of the difficulties and conditions to be dealt with, in the successful treatment of that branch of sanitation which embraces the ventilation of house drains and connections.

It will be seen, by reference to our sketch, that the "Manchester System" as applied to house drains, while of the simplest description, fully anticipates and provides for any condition or requirement.

We shall now proceed to briefly describe the scope of Mr. Rowan's patents, in their application to other sanitary exigencies.

WATER CLOSETS, URINALS, &c.—Although the soil air from fresh soil is not regarded as dangerous, it is often most inconvenient. In public places, such as Hotels, Clubs, Railway Stations, Hospitals, Schools, &c., the effluvia arising from the water closets, *when in use*, is frequently an intolerable nuisance. The water closets, patented by Mr. Rowan, are so constructed as to obviate this—the effluvia being prevented from arising at *any time* beyond the seat. This action can be rendered entirely independent of any force derived from the wind. A similar arrangement is suited as well for urinals.

SEWERS.—The difficulties hitherto encountered in dealing with the ventilation of sewers, have exhibited that any continuous system of ventilation is not practicable, viz.: Ventilation from one end of the sewer to the other. In his report of the "Brighton Sewerage," 1882, Sir Joseph Bazalgette, referring to experiments made in 1858, for a committee of the House of Commons, on the effect produced by extracting and burning the gases of sewers by means of furnaces, goes on to remark: "These experiments were conducted with the furnace in the clock tower of the Houses of Parliament, and I subsequently gave evidence before that Committee, to the effect that in the *immediate neighbourhood* of the furnace the indraught was found to be *very strong*, but that, whilst the supply of air was drawn with great force from the sewer *inlets close to the furnace*, the air current produced in the sewers at a *short distance* from the furnace was *scarcely perceptible.*"

By Mr. Rowan's *intermittent* system of sewer ventilation, any length of sewer can be so ventilated as to secure a constant abstraction of the sewer air, and its replacement with pure air; and when desired, the sewer air can be so further treated, prior to its escape to the air, that any disease germs in it are destroyed and the obnoxious smell removed.

The only plan at present employed for the so called ventilation of sewers, is having openings from the sewer to the street, with a grating placed over them, through which the foul undiluted sewer air passes to the discomfort, if not positive danger, of every passer-by. The single good feature about this plan is that it may prevent any pressure of gas in the sewer. But the sewers are always *charged* with sewer air, instead of having a current of air constantly passing through them. When it is remembered what a powerful disinfectant pure air is, the importance of having sewers dealt with so as to maintain this can be readily estimated.

THE INTERIORS OF HOUSES, HALLS, &c.— Ventilation means the abstraction or removal of the interior atmosphere, which is exhausted or partially so, and the consequent replacement of this by pure fresh air. One operation depends upon and is essential to the other. We should have deemed it unnecessary to call attention to this, but from the fact that too often it is not considered. In carrying out the process of ventilation it is therefore of primary necessity that—

First, provision be made for the abstraction of the interior atmosphere, *i.e.*, there must be *outlets.*

Second, the replacement of the abstracted atmosphere by pure air be assured, *i.e.*, there must be *inlets.*

These form the basis of the art of ventilation; and successful results depend on their proper adoption, and the methods employed for aiding the carrying out of their operations.

In the ventilation of rooms and buildings, such as Halls, Churches, &c., it is quite useless to trust to the action of cowls, however perfect in design or efficient such may be when there is wind. As we have already remarked, the interiors of buildings require most ventilation when there is least wind, and with cowls the reverse of this action takes place. The ventilation of such places must be conducted *continuously*, and, therefore, perfectly *independent of natural wind force.* By the "Manchester System" this is accomplished. The atmosphere from the interior is continuously abstracted, while the *character* of the *incoming air is controlled.* Thus it is freed from dust—in fogs it can be rendered clear, and it is otherwise treated as occasion arises, as will be hereafter mentioned. The application of this to sleeping apartments is most valuable, and should become universal.

In the scientific ventilation of the interior of buildings it is not only necessary that the abstraction of the atmosphere be continuous, but the *position* which all the air inlets occupy in relation to the outlets must be determined in accordance with physical and mechanical laws. If such be done it is possible to abstract and replace the atmosphere of rooms, &c., with a minimum of draught. It is a good rule of practice to remember that an outlet (as in the case of sewers) will draw from the nearest inlet, and if it can supply the want created by the outlet, no further action will take place from the other inlets. The volume of the air admitted to the room can only be equal to the volume of that abstracted from it. It is, therefore, not sufficient that the total area of the ingress pipes be at the very least, equal to the area of the egress pipes. The *position* in which they are placed in relation to the egress pipes is of more importance than their mere capacity, to prevent draught.

It is therefore evident that those systems of house ventilation, which depend on the abstraction of the atmosphere from all the rooms in any building being effected by *one* large shaft or chimney, are wrong in principle and cannot give successful results. If connections from each room are separately led into such a shaft, the rooms in the immediate vicinity will be acted on—the more remote rooms will not be ventilated. Or, if all the rooms are connected with one foul air chamber (as has already been advocated) from which there is a connection led to the shaft, the same action takes place—those rooms nearest the foul air chamber will supply the volume of air extracted from the foul air chamber by the shaft. These would be the natural results were the conditions the same in each room, but would be modified in some degree by the circumstances of higher temperatures, and consequently a lighter specific gravity of the atmosphere in some of the rooms, where, also, there was a free inlet of air. But in any case, having only one main shaft or chimney connected with all the rooms, is opposed to those scientific principles which must govern successful ventilation. In many of the methods proposed for ventilating the holds or compartments of ships, the above principle has been entirely ignored.

MEAT SAFES, DAIRIES, &c.—The application of the special method to Meat Safes, or Larders, Dairies, &c., is most important. In hot weather, not only can the atmosphere be continuously abstracted from the interior of such places, but the air admitted to the interior can be filtered free from dust, &c.,

cooled, and disinfected. Any rapid putrefaction of meat, or souring of milk, can be thus prevented.

HOSPITALS, &c.—Not only can the drains of Hospitals be efficiently dealt with, but also the wards, the treatment of which has been rendered an especial feature in these patents.

In the wards for SMALL-POX and other INFECTIOUS CASES, not only can the in-coming air be disinfected and otherwise treated, but the atmosphere abstracted from the interior of such wards can also be disinfected. The possibility of infection being conveyed from the vicinity of such hospitals can thus be minimised.

Mr. Rowan also treats the wards for CONSUMPTION and PULMONARY COMPLAINTS—the air admitted to such wards being so treated as to give it the character of air from a *pine forest.*

The application of the system to surgical wards is also most important.

Indeed, by the adoption of Mr. Rowan's system of ventilation and treatment of air, it is rendered possible to produce and maintain in the various wards of an hospital, or in sanitoriums, &c., those different conditions of atmosphere that correspond to *different climates.* Thus instead of having to send the patient to those localities where the climate is found to be most suitable to their physical condition, that condition of climate or atmosphere can be brought to the patient.

The part that scientific ventilation will yet take in the preventative treatment of disease has a great and most important future before it.

RAILWAY CARRIAGES, &c. —Mr. Rowan's system of Railway Carriage Ventilation is also very complete. The air from the carriages is removed by an Abstractor, of very simple construction, which derives its force from the onward motion of the carriage. The air admitted to the interior is filtered free from dust, and in Underground Railways can be thoroughly purified. In cold weather, or when desired, a constant supply of filtered *warm air* can be admitted to the carriages.

SHIPS—COAL, AND OTHER CARGOES.—The ventilation of ships and cargoes is a most important feature in Mr. Rowan's patents, and the application of his system of Abstractors to the holds or bunkers of ships, to prevent explosion and control the action of spontaneous combustion occurring in coal cargoes. The value of this can be readily understood, as the rates now charged on Underwriting Coal Cargoes for long voyages are so high as to be prohibitive. A treatise has just been written by Mr. Rowan on this subject, and published by Messrs. E. & F. N. Spon, of London. This work has been most favourably reviewed by the press throughout the country.

Other Cargoes, such as grain, &c., can be also similarly dealt with, and the carriage on board ships of substances of a volatile and inflammable nature can be conveyed with an immunity from accident.

TREATMENT OF SMOKE, &c.—The treatment of Smoke is likewise included in Mr. Rowan's sanitary patents; the object aimed at being the removal of the dust and soot, and condensation of the volatile carbonaceous products.

The process deals with the smoke from dwelling houses, but it is also adapted for the treatment of smoke from factories, and provision is made for the removal, when necessary, of acids, sulphur compounds, &c., from the smoke of chemical or similar factories. The smoke from dwelling houses has not yet been the subject of legislation, from the fact that up to the present time a practicable method for dealing with it has not yet been found. It is well known that this subject has occupied much attention of late, and that the increasing amount of fogs which our larger cities are visited with, is thought to be greatly due to the increased production of smoke from domestic as well as manufacturing sources.

STOVES, &c.—Mr. Rowan's Patents also deal with the sanitary requirements of Stoves, &c. In Mr. Rowan's Patent Stove the products of combustion are so treated that the condensable portion is condensed, and the other impurities absorbed. Gas or Oil Stoves can thus be used without the necessity of flues, and without injury to health or discomfort from smell. In these Stoves the maximum of heat is obtained from a minimum of fuel.

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